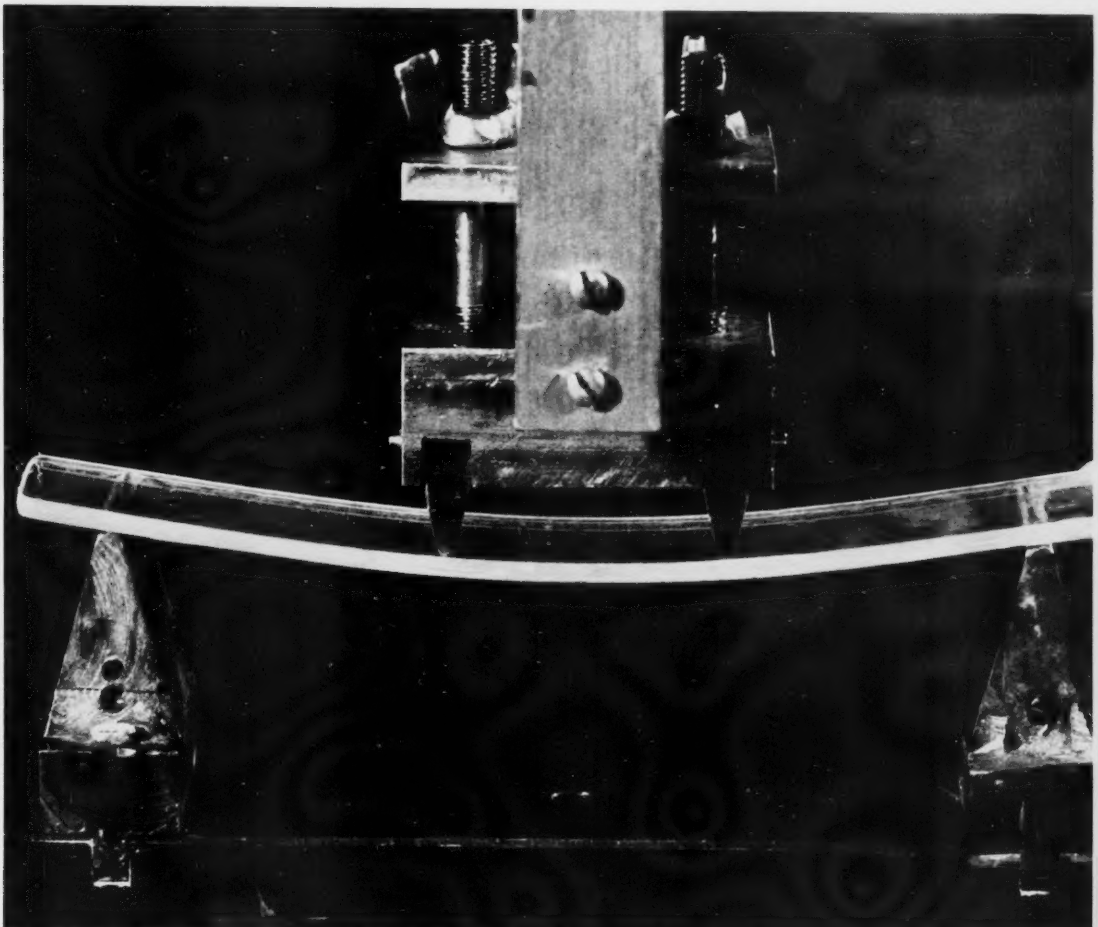
NATIONAL BUREAU OF STANDARDS October/1966

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

OCTOBER 1966/VOL. 50, NO. 10/ISSUED MONTHLY

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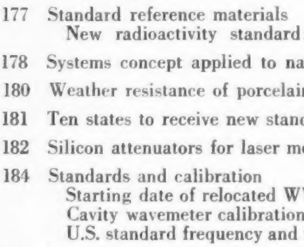

COVER

The pronounced deflection of chemically strengthened glass is clearly demonstrated in this test. This glass specimen is sustaining a stress of 45,000 psi. (See story on page 173.)

U.S. DEPARTMENT OF COMMERCE
John T. Connor, Secretary

NATIONAL BUREAU OF STANDARDS
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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—
• The Institute for Basic Standards
• The Institute for Materials Research
• The Institute for Applied Technology
The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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Library of Congress Catalog Card Number: 25-26527

T. G. Scuderi examines a specimen of chemically strengthened glass that is undergoing a modulus of rupture test.

Mechanical Properties of Chemically Strengthened Glass

AT ELEVATED TEMPERATURES

Research laboratories, aircraft manufacturers, and users of safety glass are finding an increasing number of applications for chemically strengthened glass. Not only does this glass have high mechanical strength but it also can be produced in thin cross sections to achieve light weight. Glass with these properties may be used for aircraft windshields, safety lenses, and in construction of underwater apparatus.

Chemically strengthened glass is made by placing the glass surface in compression. This is accomplished by surface crystallization, ion replacement in the surface, or some combination of the two processes.

To facilitate applications of such glass, the NBS Institute for Materials Research, at the request of the Air Force Materials Laboratory, has evaluated its mechanical properties at temperatures from 24 to 600 °C. These tests,[1] conducted by M. J. Kerper and T. G. Scuderi, have measured Young's modulus, shear modulus, and the modulus of rupture for the glass at these temperatures. In addition, its mechanical properties and delayed elasticity were compared to those of thermally strengthened glass.

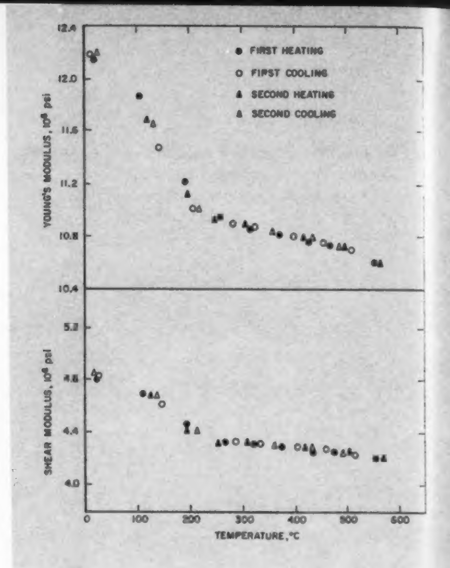
In the NBS tests, specimens of two sizes were used. Samples of each size were supplied from two manufacturers. One size was 10 in. by $1\frac{1}{2}$ in. by $\frac{1}{4}$ in., as recommended by ASTM. The other size, 6 in. by 1 in. by 0.1 in., had the thickness that manufacturers deem desirable for many applications.

Elasticity

Young's modulus and shear modulus were determined by a dynamic resonance method.[2] Measurements were obtained during two heating and cooling cycles. During these cycles the temperature was raised at the rate of 80 deg C per hour up to 600 °C and then cooled at 50 deg C per hour. At approximately 50-deg intervals between room temperature and 600 °C the temperature was held constant for 10 minutes. This allowed the specimens to come to thermal equilibrium for measurements.

The information from these tests revealed the following: (1) Young's modulus and the shear modulus decreased as temperature increased. (2) Young's modulus plotted in relation to temperature showed an inflection in the curves, slightly above room temperature, with each of the harmonics displaced to higher temperatures in the inflection regions. This dis-

continued



Young's modulus and sheer modulus are shown in relation to temperature during two heating and cooling cycles for chemically strengthened glass.

GLASS *continued*

placement revealed the frequency-dependent characteristics of relaxation phenomena, and indicated an internal friction peak. (3) It was also found that the glass had a considerable reduction in center stress after heating, with no reduction of Young's modulus. This reduction in stress well below the annealing range of the glass is caused by a composition-induced migration of ions.

The specimens were also tested for delayed elastic effect. In this test the samples were loaded in flexure using the two-point loading method. The same loading and support spans used in the modulus-of-rupture testing were employed except that rollers were substituted for knife edges.

Two 10 inch by $1\frac{1}{2}$ inch by $\frac{1}{4}$ inch thermally tempered specimens were included in the elastic properties study for the purpose of comparison. The results of this comparison were as follows: (1) Chemically strengthened glass shows no appreciable change in elasticity after repeated heating to 600 °C for short periods of time (15 min), whereas thermally heated glass shows increased elasticity after the first heating. (2) At room temperature chemically strengthened glass shows nearly five times as much delayed elastic effect as thermally strengthened glass.

Strength

The modulus of rupture tests were performed on abraded and unabraded specimens, using the two-point loading method. Samples were tested at temperatures of 24, 93, 149, 204, and 260 °C. In order to study the effect of long-time exposure to temperature some specimens were held at elevated temperatures for periods of 100, 300, and 500 hours, then allowed to cool to room temperature previous to the tests.

The specimens were heated to the desired temperature, held for 10 minutes to attain thermal equilibrium, then tested to failure. In addition, two rates of loading were tested. One group of samples was loaded at 10,000 psi-min and another at 60,000 psi-min.

The results of these tests permit the following observations: (1) The modulus of rupture is not affected by short exposure to temperatures up to 260 °C but drops appreciably when the specimens are exposed to temperatures above 204 °C for 200 hours or more. (2) The rate of loading made no appreciable difference in results. (3) Abrading reduced the strength by 25 to 30 percent. (4) All unabraded specimens failed from the edge, indicating that edge condition controlled the strength of the glass.

[1] For further technical details, see **Mechanical properties of chemically strengthened glass at elevated temperatures**, by M. J. Kerper and T. G. Scuderi, J. Am. Ceramic Soc. (in press).

[2] **Accurate computation of elastic moduli**, NBS Tech. News Bull. **47**, 3 (1963).

Coming Next Month . . .

Special dedication issue of the Technical News Bulletin—a survey of the Bureau's new facilities at Gaithersburg, Md.

Titanium Alloy Tested For Strength

Effects of Temperature and Notch Geometry Evaluated

Both aircraft and space industries have increasing need for metals and alloys that have high strength-to-weight ratios and good notch toughness. An indication of durability, notch toughness (or notch sensitivity) is related to the ratio of the tensile strength of a notched specimen to the tensile strength of an unnotched specimen at the same temperature. One alloy that has these favorable characteristics is that of titanium–8 aluminum–1 molybdenum–1 vanadium.

To facilitate applications of this alloy, the NBS Institute for Materials Research has recently completed a study of its mechanical properties. This study,[1] by William D. Jenkins and William A. Willard, has determined the effects of temperature [75 to 1200 °F (24 to 649 °C)] and notch geometry (depth and angle) on the tensile and yield strength of the alloy.

The NBS tests were performed on cylindrical notched and unnotched rods that were approximately 6.5 inches (16.25 cm) long and 1 inch (2.5 cm) in diameter. The notched rods had circumferential V-notches cut at their midpoints. The desired notch geometry was obtained by cutting a notch in each specimen to the same notch diameter. The outside diameters were then reduced varying amounts to produce the desired notch depth (10 to 85 percent).

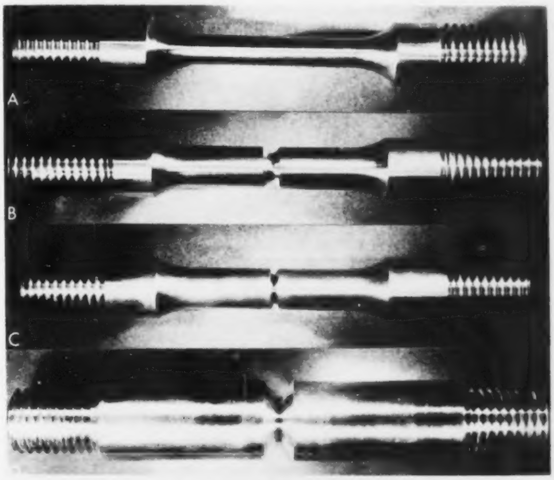
All specimens were duplex annealed. First they were heated to 1750 °F (945 °C) and held for one hour. This was followed by a stabilizing anneal for 8 hours at 1050 °F (561 °C).

Tensile properties were determined on a hydraulic machine whose crosshead movement was controlled to produce 1 percent of strain per min for each specimen. For each test the specimens were heated to the desired temperature by means of a tube furnace. They were held at this temperature for one hour to obtain thermal equilibrium, then tested to fracture.

The yield strength values of the alloy were calculated for the unnotched specimens by the 0.2 percent offset method. For the notched specimens values of yield strength were based on the stress at the first observable occurrence of plastic deformation. These values were further confirmed by load-time observations made throughout the tests. True stress at fracture values were calculated by dividing the load at fracture by the cross-sectional area of the specimen after fracture.

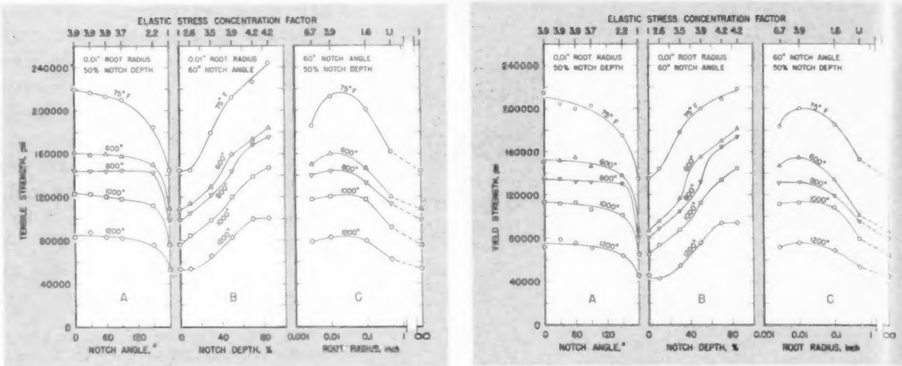
Results of the tests for both tensile and yield strength show that: (1) strength decreased as the temperature was increased; (2) strength increased as notch depth was increased and as the notch angle was decreased (fig. 2 and 3); (3) strength increased as root radius of the notch was decreased but there appeared to be a maximum in the vicinity of 0.01 inch; and (4) the point of initiation of fracture progressed toward the axis as temperature was increased.

[1] For further technical details, see **Effect of notch geometry on tensile behavior of a titanium alloy**, by W. D. Jenkins and W. A. Willard, J. Res. NBS **70C** (Engr. & Instr.), No. 1, 5–11 (Jan.–March 1966).



(Top) these four specimens are representative of the notch geometry of a titanium–8 percent aluminum–1 percent molybdenum–1 percent vanadium alloy tested to determine strength in relation to notch geometry and temperature. (Bottom) W. M. Jenkins tests a notched titanium alloy in tension. The specimen (at left) is in a hydraulic testing machine. The load applied is read from the dial and load extension is recorded (upper center).

The yield and tensile strength of a titanium alloy are shown graphically. Strength is shown in relation to notch angle, notch depth, and root radius for temperatures up to 1200°F.



Committee To Aid in Pre-Coordination of Building Components and Systems

Today in this country a large part of the money spent for building construction is wasted because many of the thousands of parts used in a building must be custom modified during construction. These parts are produced as independent entities, by unrelated manufacturers, and must be coordinated to function as an integrated system in a finished building. If such products could be coordinated before manufacture, they could be assembled without costly modification. For pre-coordination to be successful, however, industry must establish guidelines and standards for product designers to follow.

To assist industry in establishing such guidelines and standards, the American Standards Association Sectional Committee A62 is being reorganized under sponsorship of the NBS Institute for Applied Technology. Earlier this year, the Construction Standards Board of ASA approved an ad hoc study committee recommendation that the A62 activity be reactivated with a new name and expanded scope, and approved the Institute as the new project's sponsor.

The reactivated project will be called, "A62, Pre-coordination of Building Components and Systems," and have as its scope:

> "The development of a basis for attaining both functional and dimensional compatibility and interchangeability of building components so that they integrate with a minimum of on-site modification, and the establishment of guidelines for coordinating building systems. This activity is limited to the interface requirements of components or systems or both."

In its capacity as sponsor, the Institute has named Jack E. Gaston, Armstrong Cork Co., as Chairman and Russell W. Smith of the Institute staff, as Vice Chairman and Secretary of the Committee.

This summer is being used to identify Committee participants and areas of industry interest in standardization, and to outline a proposed program and work procedure. The first organizational meeting of the new A62 Sectional Committee is planned for this fall, at which time the proposed program will be presented and subcommittee assignments made on specific standardization tasks.

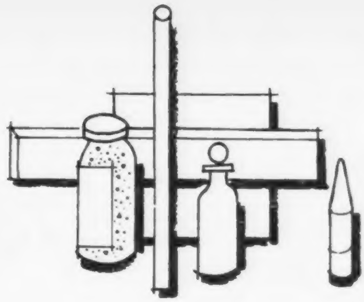
This project is an attempt to establish, within ASA, a centralized organization of producers and users to furnish industry needed guidance for systems development. NBS will function as organizer and coordinator, working with industry in a large number of subcommittees that will develop different facets of the problem.

The program is expected to involve a succession of small working committees that will develop basic criteria for coordinating various types of building components. Larger working committees will identify the most meaningful systems criteria as guides for the component committees. Various technical study committees will look at pre-coordination as a systems problem. each committee involving different technology, organizations, and solutions.

This activity will be essentially long-term. although the possibility of developing standards with short-term value is not ruled out. Organizations, corporations, or individuals who have an interest in participating in the program should contact the committee Secretary.

Russell W. Smith
National Bureau of Standards
Washington, D.C. 20234

STANDARD REFERENCE MATERIALS



NEW RADIOACTIVITY STANDARD: CERIUM-PRASEODYMIUM-144

A new radioactivity standard, cerium-praseodymium-144, has been added to the nearly 600 other standards issued by the NBS Office of Standard Reference Materials.[1] This new standard, NBS No. 4948, is both a beta-ray and gamma-ray standard for accurately calibrating detectors and detector-spectrometer systems used in the measurement and identification of cerium-praseodymium-144. These radionuclides are found in fallout and fission products. They are used in industry for radiography, as tracers, and as power sources. They are also used by the medical profession for teletherapy.

NBS Standard No. 4948, containing 3.34g of solution, has an activity of 1.6×10^5 dps (disintegrations per second) per gram of solution, as of December 1965, and costs $80 apiece.*

The following general information on cerium-praseodymium-144 is taken from the literature.[2, 3] Cerium-144, with a half life of 285 days, has three beta-ray branches with maximum energies of 186, 240, and 320 keV, and 7 gamma rays with energies ranging from 34 to 133 keV. Praseodymium-144, the daughter, has a half life of 17.5 minutes. It has 3 beta-ray branches with maximum energies of 803, 2293, and 2984 keV, and 3 gamma rays with energies ranging from 691 to 2181 keV.

Reissued Standards

Six other radioactivity standards have been reissued to replace out-of-stock standards.* These standards are NBS Nos. 4904–B, americium-241; 4932–D, mercury-203; 4944–C, iodine-125; 4990–B, carbon-14 dating standard; 4995–B, mercury-203; and 4997–D, manganese-54.

NBS Standard No. 4904–B, americium-241, replaces No. 4904–A and is a point-source standard with an aplha-particle emission rate into 2π geometry of approximately 20 αps. This standard may be ordered under the general licensing provisions of the Atomic Energy Act of 1954 for $77. (Please refer to Section 31.8, Title 10, Code of Federal Regulations, Part 31.)

NBS Standard Nos. 4932–D (mercury-203) and 4944–C (iodine-125) are reissues of Nos. 4932–C and 4944–B, and are beta, gamma, and electron-capture solution standards. NBS No. 4932–D has a total activity of approximately 2.1×10^6 dps per gram of solution as of January 1966. The standard ampoule contains 5.12g of solution and costs $50. NBS No. 4944–C contains 5.05 grams of solution and costs $53. The activity of this standard was approximately 1.5×10^5 dps per gram of solution as of March 1966. Both of these standards can be issued only under the special licensing provisions of the Atomic Energy Act of 1954. Therefore, a copy of the purchaser's current AEC By-Product Material License is required to be on file at NBS.

NBS No. 4990–B, carbon-14 dating standard, is a reissue of No. 4990, a contemporary standard for carbon-14 dating laboratories. This standard consists of 1 lb of oxalic acid and costs $6. It is shipped parcel post prepaid.

NBS Standard Nos. 4995–B (mercury-203) and 4997–D (manganese-54) are reissues of Nos. 4995–A and 4997–C, and are point-source standards. No. 4995–B has an emission rate of approximately 8×10^4 gamma rays per second as of March 1966, and costs $63. No. 4997–D has an emission rate of approximately 6×10^4 gamma rays per second as of June 1966; the cost of this standard is $53. Both of these standards may be ordered singly under the general licensing provisions of the Atomic Energy Act of 1954. (Please refer to the *Federal Register*, Volume 21, p. 213, January 11, 1956.)

[1] For a complete list of NBS standard materials, see **Standard Reference Materials: Catalog and Price List of Standard Materials Issued by the National Bureau of Standards**, NBS Misc. Publ. 260, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 45 cents.

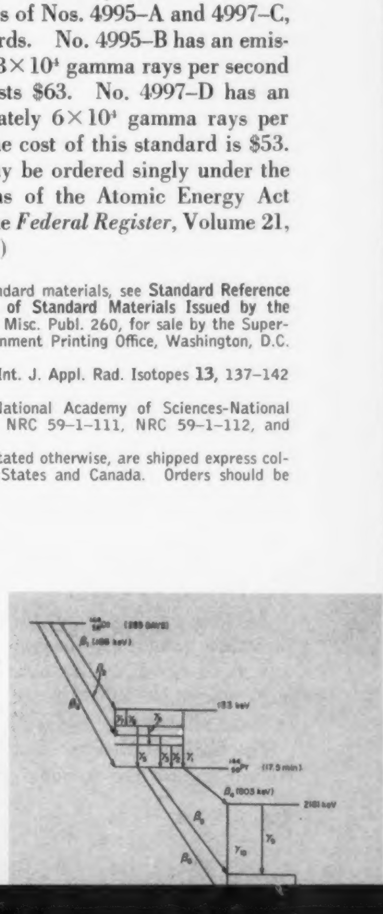
[2] H. Houtermans and M. Miguel, Int. J. Appl. Rad. Isotopes **13**, 137–142 (1962).

[3] Nuclear Data Sheets of the National Academy of Sciences-National Research Council: NRC 59–1–106, NRC 59–1–111, NRC 59–1–112, and NRC 59–1–113.

*Radioactivity standards, unless stated otherwise, are shipped express collect to destinations in the United States and Canada. Orders should be addressed to:

Julia C. Holland
Radioactivity Section, IBS
National Bureau of Standards
Washington, D.C. 20234

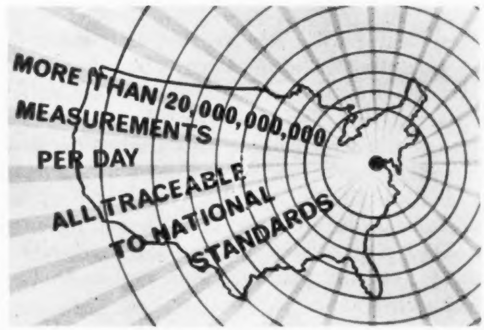
The cerium-praseodymium-144 decay scheme, based on general information contained in the literature,[2 3] shows the 3 beta-ray and 7 gamma-ray branches for the cerium-144 with the energy scale enlarged, and the 3 beta-ray and 3 gamma-ray branches for the praseodymium-144 with the energy scale reduced.



Systems Concept Applied to Nation's Measurement Activities

NBS Scientist Postulates a National Measurement System

About 20 billion measurements are being made every day in this country—in science, in industry, and in everyday life—according to Dr. Robert D. Huntoon, Director of the NBS Institute for Basic Standards. Thus the activity level in the National Measurement System (NMS) is quite comparable with that in other important national systems such as communication or transportation. The NMS now represents a total investment, he estimates, of about $50 billion, largely for instrumentation and data-producing research.



THE NATIONAL MEASUREMENT SYSTEM

Cost and Scope

	INVESTMENTS IN MEASUREMENTS	ANNUAL INCREMENT
INSTRUMENTS	$25 BILLION	4.5 BILLION
DATA	20 BILLION	3 BILLION
	$45 BILLION	7.5 BILLION

PERSONNEL $10 BILLION per year (est)

99% Self Financed

Speaking on "The National Measurement System" at the 1966 Standards Laboratory Conference (held May 9–12, 1966 at NBS, Gaithersburg, Md.), Dr. Huntoon introduced the systems approach as a new way of looking at the vast complex of measurement activities which have paced our national scientific and technological growth. Such an approach, he indicated, makes it possible to see these activities in broad perspective, to evaluate the effectiveness of the overall System and its various elements, and to take whatever action is necessary to improve the System's operation and output. In the long run, the systems approach should lead to more accurate measurement throughout the Nation—and thus to the more rapid advancement of science and technology, which have their foundations in measurement.

According to Dr. Huntoon, an essential function of the NMS is to provide a firm quantitative basis for the interchange of goods and services in commerce, of machine parts and devices in industry, and of scientific and technical information.

"This interchangeability function," he said, "makes it possible for any plant to mass-produce materials, parts, and systems that are interchangeable with those made in plants in other parts of the country. Without this basis for interchangeability, our industrial economy as we know it today could not exist."

Another important function of the NMS, he said, is to provide a quantitative basis for decisions for action in all aspects of our daily life. An aircraft pilot, for example, must read a number of measurement output dials in order to make vital decisions during a flight.

The National Measurement System is as essential to the Nation as are the national systems of communication, transportation, and defense. In fact, these other national systems could not operate without the measurement basis provided by the NMS, and it in turn depends on the other national systems as they all interact together to form the basis of our industrially based society.

Indicative of the scope of the NMS are the 25 billion dollars which the United States has invested in measuring instruments alone. Each year the instruments industry adds another $4\frac{1}{2}$ billion to this total.

Dr. Huntoon said the role of NBS in the National Measurement System is to provide the central core of the System as a basis for uniformity and compatibility, and to provide central Federal leadership—to guide the overall System as it continues to operate through voluntary coop-

eration of American science and industry, and to help it operate with maximum effectiveness. The cost of the NBS role is estimated at less than one-half of one percent of the total cost within the System.

The central core of the NMS consists of the national standards of physical measurement—42 highly precise standards for such quantities as length, voltage, light intensity, neutron frequency, and so on. From this central core, measurement networks lead outward to all citizens—scientists, engineers, business men, and factory workers. By providing the capability for uniform, accurate measurement, these measurement networks make the actions, products, materials, and services of each citizen compatible with those of others throughout the Nation and the world. For example, an airplane pilot's decisions based on measurement (as indicated by his instruments) must be compatible with those of others who are making similar measurements if he is to stay on course, avoid collisions, and arrive on time.

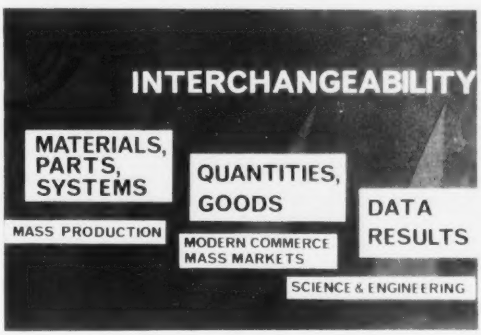
The NMS consists of two interwoven systems. One is an intellectual system which is a rational structure of rules, laws, principles, agreements, and conventions upon which the design of the other, the *operational system*, is based. The operational system consists of interrelated, interacting functional elements, aggregations of people, each with stated functions, inputs to and outputs from other elements of the System and the interfaces with the other natural systems.

The operational system may be broken down into three major networks: (1) an *instrument network* which provides the calibrated instrumentation for making measurements, (2) a *reference data network* which gives ready-made answers to measurement problems, and (3) a *techniques network* which tells the user how to make meaningful measurements.

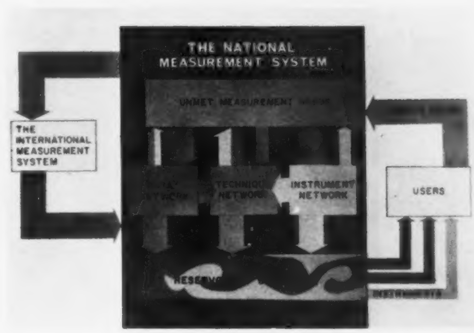
Through the instrument network, reference standards and measuring instruments that are traceable ultimately back to the national standards are disseminated to the users. The NBS Institute for Basic Standards (IBS) provides the central core of national standards and a calibration service that connects the core outward to the terminals of the network.

The objective of the reference data network is to provide all output terminals with reliable values for measurements of the kind that can be used over and over again once they have been recorded and published. These data (ready-made answers) supplied by the data network take a load off the instrument network by avoiding duplication of measurements. For the data network, IBS makes measurements of key data and administers the National Standard Reference Data System, which involves critical evaluation and dissemination of data on the properties of stable substances on a nationwide basis.

The techniques network is concerned with the dissemination of information on measurement procedures and techniques. It provides a channel through which people throughout the NMS can be told how to make optimum use of the measurement capability developed in the instrument network and the data network in order to make meaningful measurements—that is, first, to determine what is meaningful to measure and, secondly, to ensure that they measure what they set out to measure.



The National Measurement System provides a firm basis for the interchange of machine parts and devices in industry, of goods and services in modern commerce, and of scientific and technical information.



A representation of the National Measurement System showing its connection to the international system, its pool of unmet needs, and its reservoir of capability that users draw upon. The system is divided into three major networks: (1) The instrument network which provides calibrated instrumentation for making measurements, (2) the data network which gives ready-made answers to measurement problems, and (3) the technique network which tells how to make meaningful measurements.

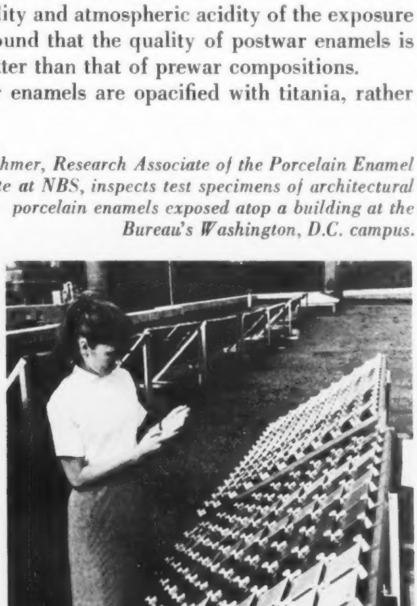
Weather Resistance of Porcelain Enamels Studied

In modern architecture the use of porcelain enameled steel and aluminum has increased and is still increasing because of the emphasis on colorful building materials that are long-lasting and maintenance-free. This trend has emphasized the need for data on weather resistance of the various types of enamels, particularly those introduced since World War II.

Recently seven types of postwar porcelain enamels were evaluated for weather resistance in a study [1] at the NBS Institute for Applied Technology. These enamels were exposed to various climatic conditions in the United States for seven years. M. A. Rushmer and M. D. Burdick, Research Associates of the Porcelain Enamel Institute (PEI) at NBS, correlated the enamels' color and gloss retention with the acid resistance of the enamel, and also with the humidity and atmospheric acidity of the exposure sites. They found that the quality of postwar enamels is equal to or better than that of prewar compositions.

The postwar enamels are opacified with titania, rather than antimony or zirconium oxide which were used for most prewar enamels. In addition, several new types of enamels are now available, such as glossy and mat (low-gloss) enameled aluminum and enameled steel fired at lower temperatures (1000 and 1300 instead of 1500 °F).

Margaret Rushmer, Research Associate of the Porcelain Enamel Institute at NBS, inspects test specimens of architectural porcelain enamels exposed atop a building at the Bureau's Washington, D.C. campus.



Weather resistance data on prewar enamels were previously obtained from a 15-yr exposure test which ended at three of the four sites in 1955. The results of that test strengthened confidence in laboratory tests used to indicate an enamel's weatherability and suggested exposure tests on postwar enamels. A new 15-yr exposure test was begun in 1956 with 91 enamels representing 7 different enamel types. After the first seven years of exposure in the new 15-yr test, the specimens were brought to NBS where they were cleaned and inspected. The inspection of the regular glossy enameled steels exposed at Washington showed an average of 2 percent higher (64.6 vs 62.5 percent) gloss retention that was found for similar prewar enamels that were also exposed at Washington for 7 years.

Enamel Exposure

The average atmospheric conditions at the exposure sites used range in temperature from 50 to 70 °F, in relative humidity from 62 to 77 percent, and in acidity of airborne dirt from a pH of 4.9 to 7.3. The enamels are exposed on the roofs of Government buildings in Dallas, Texas; Los Angeles, Calif.; Pittsburgh, Pa.; New Orleans, La.; and Washington, D.C. Also, two groups are exposed at Kure Beach, N.C., one 80 ft and the other 800 ft from the ocean.

All enamels lost gloss most rapidly during the first three years, after which gloss remained nearly constant at all but the two Kure Beach sites. The rate of decrease in gloss at the individual sites illustrated the severity of the various exposure conditions. The Kure Beach site 80 ft from the ocean was the most severe while that at Dallas was the least. The same trends were evident regarding color loss.

In determining the cause of gloss and color loss, weather data and air quality measurements, respectively, were obtained from the U.S. Weather Bureau records and the Air Sampling Network of the U.S. Department of Health, Education, and Welfare. In general, these data showed the atmosphere at the sites that caused the greatest changes in gloss and color of the enamel had acidic pH values while the sites where smaller changes in the enamels occurred had nearly neutral pH values. The data for the Pittsburgh and Los Angeles sites did not follow this pattern, but this may be explained by the protective action of adherent films that built up on specimens at these sites.

As to relative humidity, the enamels exposed at sites with high humidity generally lost more gloss and color than those at the drier ones. Although the New Orleans and Washington sites were exceptions, a definite pattern was evident.

A possible explanation of these effects is the interaction of the humidity and acidity. In areas of high humidity, the moisture condenses on the enamel surface and dissolves the acidic material suspended in the surrounding air. Thus, enamels exposed at a site with high humidity and acidic atmosphere may show less color and gloss retention than those exposed at a site with low humidity and a more nearly neutral atmosphere.

Resistance of New Types of Enamels

The weather resistance of the enamels on steel, fired at 1300 °F, was equal to that of the regular glossy acid-resistant enamels on steel fired at 1500 °F, while the enameled steel fired at 1000 °F showed appreciably less color and gloss retention.

The enamels on aluminum showed good stability at all but the Kure Beach sites. For these enamels the mat finish showed less change than the glossy finish and at three sites the mat enameled aluminum had color retentions not significantly different from the glossy acid-resistant enamels on steel.

[1] For further information, see **Weather Resistance of Porcelain Enamels Effect of Exposure Site and Other Variables After Seven Years,** by M. A. Rushmer and M. D. Burdick, NBS Bldg. Sci. Series No. 4 (in press); also, see **Weather resistance of porcelain enamels exposed for seven years at various sites,** by M. A. Rushmer and M. D. Burdick, Proceedings of the Porcelain Enamel Institute Forum **26,** 214–226 (October 1964).

Ten States To Receive New Standards

In a program to update the standards of all 50 States in the next five years, Secretary of Commerce John T. Connor recently named the first ten States to receive new sets of weights and measures standards. The ten States are California, Connecticut, Delaware, Illinois, Kentucky, New Mexico, Ohio, Oregon, Tennessee, and Utah. The new standards will be available to each of the ten States by the fall of this year. Ten additional States will receive new sets in each of the next four years.

The National Bureau of Standards is supervising the replacement of the States' obsolete standards to update and extend measurement competence throughout the Nation. Many standards and instruments now used by the States in weights and measures administration were provided by the Federal Government more than a hundred years ago.

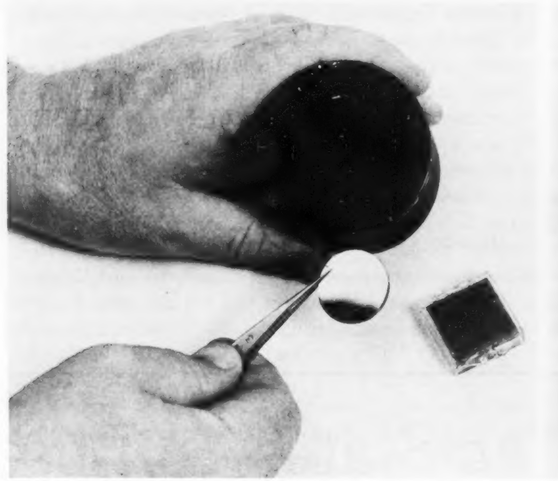
The new sets include standards of mass, length, and volume. In addition, the necessary laboratory instruments, such as high-precision balances designed specially for the State weights and measures laboratory, will be included.

Each new set is supplied by the Federal Government at a cost of approximately $70,000, including calibration, installation, and training of laboratory personnel. The States' contribution will be in the form of new or expanded laboratory facilities and better qualified personnel.

Measurement uniformity among the States began in 1838 when Congress authorized the Federal Government to supply each State with ". . . a complete set of weights and measures adopted as standards—to the end that a uniform standard of weights and measures may be established throughout the United States."

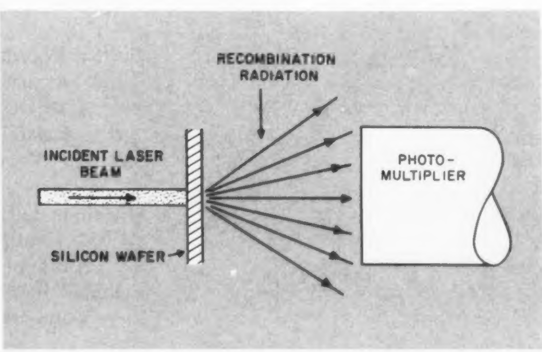
In recognition of the long history of excellent Federal-State cooperation in the field of weights and measures, and in commemoration of the presentation of the new standards, each of the ten States has agreed to donate a tree that is both native to the State and suited to the Maryland climate. The trees wll be planted in a grove on the grounds of the new NBS laboratories at Gaithersburg, Maryland. An appropriate metal plaque will identify each tree, its donor, and the date of planting. It is hoped that trees from the other States will be planted in the grove by the time they have received their new standards.

A representative set of the mass standards which NBS will issue to the 50 States in a program to modernize their standards over the next five years. (Photograph courtesy Allegheny Ludlum Steel Corp.)



A disk of silicon is being placed over the aperture of a photodetector housing to serve as an attenuator. The polished silicon absorbs the laser beam within the first 10^{-4} cm of its travel and gives off some of its energy as radiation from the far side.

Silicon Attenuators for Laser Measurements



Radiative recombination processes take place in silicon attenuators used to reduce the intensity of a laser beam to the point where it can be measured by conventional radiometric systems. The incident laser beam is absorbed by the attenuator which then gives off radiation at a longer wavelength and this is measured by the photomultiplier.

Attenuators composed of elemental silicon have been used by N. N. Winogradoff and H. K. Kessler for ruby and gallium arsenide laser beam measurements at the NBS Institute for Applied Technology.[1] Unlike conventional glass attenuation filters, the pure silicon disks can be obtained at low cost and remain unchanged in attenuation factor. The silicon attenuates the laser beam by means of a reradiation process, reducing intensity sufficiently for the output pulse shape to be measured by calibrated photomultipliers. This research was performed for the metrology laboratories of the Bureau's Institute for Basic Standards.

Laser Beam Measurements

Accurately measuring the output energy is one of the major problems in characterizing and standardizing lasers. Photodetectors used in conventional radiometric measurements are generally calibrated against low-intensity blackbody sources; their use at higher intensities

by extrapolation may introduce major uncertainties. In addition laser beams are intense enough to damage the detector.

One approach to the problem has been to attenuate the laser beam by means of calibrated glass filters of suitable thickness and colors. Unfortunately, even a single flash of an intense laser beam may bleach the filters or otherwise alter their transmission characteristics.

Silicon Attenuators

Dr. Winogradoff and Mr. Kessler have greatly simplified the attenuation problem by substituting elemental silicon for the glass. The silicon absorbing the radiant energy is excited and subsequently reradiates at a longer wavelength. The new radiometric technique uses the low efficiency of wavelength conversion to obtain the required attenuation. The silicon samples can be prepared with a high degree of purity and reproducibility at relatively low cost.

Recombination Radiation

In using the silicon attenuator, the beam being measured is allowed to fall on one face of the polished silicon wafer; the radiation is completely absorbed in the first 10^{-4} cm of material. This produces a large number of free electrons and holes in the silicon. These excess carriers recombine by radiative and nonradiative processes, the former producing radiation at a wavelength longer than that in the beam being measured. Since the absorption coefficient of silicon for its own recombination radiation is low, some of this radiation will emerge from the back surface of the silicon attenuator.

The low efficiency of the radiative recombination process in silicon permits the intensity of the radiation to be measured by direct radiometric techniques. The efficiency of conversion from the incident to the emerging beam is nonlinear, yielding a response curve that is characteristic of the material used. Further fundamental studies of properties of the radiative recombination processes are expected to result in accurate power and pulse-shape measurements using this technique.

The recombination technique also permits measurements showing the fine detail in intensity variations within a laser flash with a resolution of better than 2×10^{-8} sec. Other semiconductors can be used to extend the wavelength range of the technique into the infrared.

[1] Radiative recombination lifetimes in laser-excited silcon, by N. N. Winogradoff and H. K. Kessler, Appl. Phys. Lett. 8, 99–101 (15 Feb. 1966).

N.N. Winogradoff places a cap bearing a silicon attenuator over a photomultiplier tube, to "attenuate" a laser beam sufficiently for measurement. Attenuators made of silicon are inexpensive and, unlike conventional glass filters, are relatively unaffected by energy absorbed from the beam.

Light from a ruby laser stimulated by a flash from a xenon tube (right) is studied by diverting part of the beam at a 45° reflecting surface. The rest of the beam passes through the reflector and the silicon attenuator. Recombination of free carriers in the silicon produces sufficient radiation for radiometric observation of the beam pulseform, but not enough to harm the photomultiplier.

STANDARDS AND CALIBRATION

STARTING DATE OF RELOCATED WWV

It has been announced [1] that, effective 0000 UT, Dec. 1, 1966, all of the services presently provided by the National Bureau of Standards broadcast station WWV, Greenbelt, Maryland, will be continued by WWV, Fort Collins, Colorado. Unavoidable delays in equipment procurement and building construction necessitate the change to Dec. 1, 1966, from the original target date of July 1, 1966.

All six carrier frequencies—2.5, 5, 10, 15, 20, and 25 MHz—will be transmitted by omnidirectional vertical half-wave dipoles having the following locations:

	Latitude	*Longitude*
2.5 MHz:	40°40′55.2″ N.	105°02′31.3″ W.
5 MHz:	40°40′42.1″ N.	105°02′24.9″ W.
10 MHz:	40°40′47.8″ N.	105°02′25.1″ W.
15 MHz:	40°40′45.0″ N.	105°02′24.5″ W.
20 MHz:	40°40′53.1″ N.	105°02′28.5″ W.
25 MHz:	40°40′50.5″ N.	105°02′26.6″ W.

Requests for further information should be addressed to: Director, National Bureau of Standards. Attention: Broadcast Services 251.02, Boulder, Colorado 80302.

[1] Federal Register **31**, p. 9089 (July 1, 1966). Plans for the relocation of WWV were described in NBS Tech. News Bull. **49**, 215.

CAVITY WAVEMETER CALIBRATION EXTENDED TO 90 GHz

The Radio Standards Laboratory, Boulder, Colorado (NBS Institute for Basic Standards) announces that calibration of cavity wavemeters is extended to 90 GHz from the former frequency range of 2.6 to 75 GHz. Measurements are made on fixed or variable cavity wavemeters.

Experience gained over a period of years indicates that calibration accuracies of approximately 1 part in 10^6 can be obtained with cavity wavemeters in the region of 10 GHz (X-Band). At frequencies approaching 90 GHz, calibration accuracies are slightly less than 1 part in 10^6. Usually, but not always, the calibration accuracy of variable cavity wavemeters is limited principally by the dial resettability of the wavemeter tuning mechanism. The ability of the wavemeter tuning mechanism to return to the same dial setting, the smallest division (least count) on the scale, and other factors must be considered in determining the resettability of the instrument.

U.S. STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz
WWVH—2.5, 5.0, 10.0, and 15.0 MHz
WWVB—60 kHz

Radio stations WWV (Greenbelt, Md.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. Adjustments are made at 0000 UT (7:00 p.m., e.s.t.) on the first day of a month. There will be no adjustment made on 1 November 1966. The pulses occur at intervals that are no longer than one second by 300 parts in 10^{10} due to an offset in carrier frequency coordinated by the Bureau International de l'Heure, Paris, France.

Radio station WWVB (Ft. Collins, Colo.) broadcasts seconds pulses derived from the United States Time Standard (USTS) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. NBS directs that such adjustments be made in the scale at intervals to maintain the seconds pulses within about 100 ms of UT2. There will be no adjustment made on 1 November 1966.

Symposium To Be Held in 1968

A symposium to be entitled "Accurate Characterization of the High Pressure Environment," will be held at NBS in March 1968 at its Gaithersburg, Maryland facility.

Purpose of the symposium will be to obtain an authoritative survey of the problems of pressure, temperature, and related measurements in the high pressure environment. It will summarize the information needed for a provisional pressure scale, which would be of great value to industry and technology as well as to scientific research.

The NBS planning committee consists of Charles W. Beckett (Heat Division), and Edward C. Lloyd and Daniel P. Johnson (Mechanics Division). Additional information about this symposium will be published in this column in the future.

Eberhard Heads Institute; Kushner is Deputy

John P. Eberhard

Dr. Lawrence M. Kushner

John P. Eberhard has been named Director of the NBS Institute for Applied Technology, replacing Dr. Donald A. Schon, who resigned to direct The Organization for Social and Technical Innovation, Cambridge, Mass. Mr. Eberhard had been Deputy Director of the Institute since its establishment in 1964. Dr. Lawrence M. Kushner, former Chief of the NBS Metallurgy Division, has been named Deputy Director.

The NBS Institute for Applied Technology seeks to create opportunities for the introduction of new technology in Government and industry. As its chief, Mr. Eberhard will direct programs in engineering standards, building research, electronic instrumentation, textile and apparel technology, technical analysis, and invention and innovation. Also under his direction will be the Clearinghouse for Federal Scientific and Technical Information, the NBS Office of Weights and Measures, and the Center for Computer Sciences and Technology.

Before coming to the Bureau, Mr. Eberhard served as a consultant to Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, and had extensive experience as a consultant to industry, a practicing architect, and a lecturer in the School of Industrial Management, Massachusetts Institute of Technology. Mr. Eberhard was one of the incorporators of Creative Buildings, Inc., a firm that designs and manufactures prefabricated buildings. He was President of the firm from 1952 to 1958. In 1959 he became the Director of Research for the Sheraton Corporation of America.

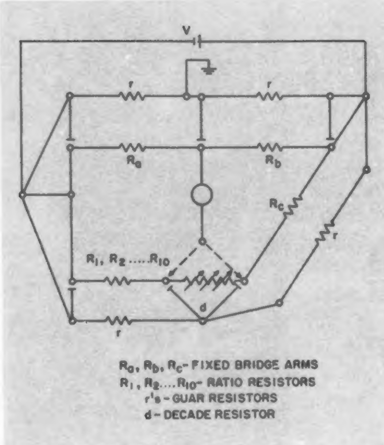
Born in Chicago in 1927, Mr. Eberhard received a B.S. degree in architectural design from the University of Illinois in 1952. He attended M.I.T. in 1958–59 under an Alfred P. Sloan Fellowship, and obtained his M.S. degree in industrial management.

Dr. Kushner was Chief of the NBS Metallurgy Division from April, 1961, until his recent appointment in the Institute for Applied Technology. He joined the Bureau in 1948 as a physical chemist in the Surface Chemistry Section, later becoming Assistant Chief of the Section. In September, 1956, he was appointed Chief of the Metal Physics Section. As a Commerce Science and Technology Fellow, Dr. Kushner worked in the office of Assistant Secretary of Commerce J. Herbert Hollomon as a Special Assistant for Legislation in 1964–65.

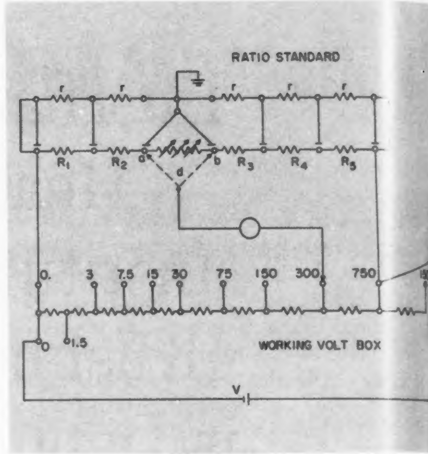
A native of New York City, Dr. Kushner graduated from Queens College with a B.S. in chemistry in 1947. He received both his A.M. and Ph.D. in physical chemistry from Princeton University.

Dr. Kushner has lectured in chemistry at American University and has served on the Ph.D. examining boards in chemistry at Georgetown University and in physics at the University of Maryland. He has been a Ph.D. thesis adviser at Catholic University and at the University of Maryland.

The author of numerous scientific articles, Dr. Kushner is a member of the American Physical Society, the Metallurgical Society of the AIME, the American Society for Metals, the American Association for the Advancement of Science, the Washington Academy of Sciences, and Sigma Xi.



The ratio standard is calibrated by using three resistors as fixed arms of a square bridge to measure the remaining ten in succession. By using a different set of three resistors for the fixed arm, the deviations of all thirteen resistors can be referred to one reference resistor.



A schematic presentation of the NBS ratio standard (top) during calibration of a step-down ratio of a volt box (bottom). The decade resistor (upper center) is adjusted to give a null on the detector (center). The decade resistor reading is then used to compute the correction for the step-down ratio that is being calibrated.

Modification Simplifies Volt Box Calibration

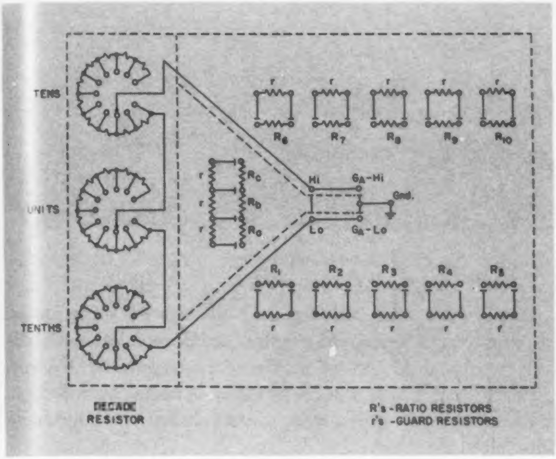
A method for calibrating volt boxes quickly and easily to an accuracy of 10 parts per million has been developed by modifying existing procedures.* This modification, recently introduced by R. F. Dziuba and T. M. Souders of the NBS Institute for Basic Standards, simplifies the measurement procedure, preserves the precision needed, and permits measurements at rated voltage for volt boxes whose self-heating errors are reasonably small.

At present volt boxes are calibrated by direct comparison with a standard volt box. An alternative technique, called the ratiometric method,[1] eliminates the use of the standard volt box and measures the step-down ratios ** of volt boxes with a calibrated Kelvin-Varley divider. The NBS modification [2] also measures step-down ratios but eliminates the need for the Kelvin-Varley divider. The new procedure employs a "ratio standard" and may be quite useful in those laboratories where the versatility of the direct comparison method and the relatively high cost of the standard volt box required are not justified.

The ratio standard is self-calibrating and a resolution of 1 ppm can be obtained in both a self-calibration and a volt box calibration. This is not always feasible when a Kelvin-Varley divider is used to measure large step-down ratios nor can most such dividers be used at the high voltages (up to 1500 volts) often required.

The ratio standard is comprised of thirteen nominally equal fixed resistors and a three-dial decade resistor. Suitable combinations of the thirteen 100,000-ohm resistors provide the ratios required to measure step-down ratios from 2 : 1 to 20 : 1. The decade resistor, which includes the 10-, 1-, and 0.1-ohm dials of a resistance box, provides the adjustment for balancing the bridge circuit when performing either a self-calibration of the ratio standard or a calibration of a working volt box.

The ratio standard is calibrated by using three resistors as fixed arms of a square bridge to measure the remaining ten in succession. By using a different set of three resistors for the fixed arm, the values of all thirteen resistors can be intercompared. When the ratio standard is being



In the NBS ratio standard used to calibrate the step-down ratios of volt boxes, the decade resistor reading (left) is used to compute corrections for a self-calibration or a volt box calibration.

calibrated the decade resistor is located in the unknown arm or one fixed arm as necessary, to balance the bridge circuit. Its setting, when multiplied by 10, gives a direct reading of deviation from nominal value in parts per million for each of the thirteen resistors. The resistors may be arranged to give any ratio required for a volt box calibration. The correction to the standard ratio is easily computed from the results of the self-calibration test.

A volt box is calibrated by comparing its successive step-down ratios with the nominally equal ratios of the ratio standard. When the decade resistor is adjusted for a null on the dectector, the correction of the step-down ratio of the volt box is computed from the dial setting of the decade resistor. This correction, when combined with the nominal value of the ratio, gives the actual step-down ratio of the volt box. The algebraic sum of the pertinent step-down ratio corrections are then used to compute the voltage ratio of each range of the volt box.

NBS tests have shown that the accuracy of volt box calibration is limited by the uncertainty of the self-heating error of the volt box. However, the present trend in designing volt boxes is to decrease the self-heating errors, by decreasing the rated current (higher ohm/volt design ratio) and by using materials having lower temperature coefficients. With this type of volt box the NBS technique serves as a useful calibration method.

The validity of this method was verified by comparing its results with results obtained in the standard volt box direct-comparison method normally used. In several tests, agreement was within 10 ppm for volt boxes whose self-heating errors were within 10 ppm; but was not as good at rated voltage on the high ranges of volt boxes which had large (50 to 200 ppm) self-heating errors.

*"Volt box" is an inexact but well-known term for a tapped resistive voltage divider that is normally used to extend the range of a precision d-c potentiometer, to measure voltages up to 1000 volts or more.

**A step-down ratio is defined as the ratio of any volt box range to its immediate lower range; for example, 3/1.5, 7.5/3, 15/7.5 . . . 1500/750.

[1] **A ratiometric method for precise calibration of volt boxes**, by Loebe Julie, Julie Research Laboratories, Inc. (1964).

[2] For technical details, see **A method for calibrating volt boxes, with an analysis of volt box self-heating characteristics**, by Ronald F. Dziuba and T. Michael Souders, IEEE Conv. Record (March 1966).

R. F. Dziuba calibrates a working volt box (lower) by means of the ratio standard (upper). The decade resistor (left side of the ratio standard) is used to balance the bridge circuit for measuring a step-down ratio.

NSRDS NEWS

This column regularly reports significant developments in the program of the National Standard Reference Data System. The NSRDS was established in 1963 by the President's Office of Science and Technology to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the National Bureau of Standards through the NBS Office of Standard Reference Data.

Tables of Molecular Vibration Frequencies Published

The unity, as well as the diversity, of today's physical science is illustrated by the fact that a single compilation of reference data can be useful to scientists working in several widely separated fields. An example is the first set of *Tables of Molecular Vibration Frequencies*, a National Standard Reference Data System publication scheduled to appear in October as NSRDS–NBS 6. The thermodynamicist will use these tables for computation of ideal gas properties. The theoretical chemist will find them valuable as an adjunct to molecular theory. The molecular spectroscopist will use them for structure-property correlations. The analytical chemist will find them a solid foundation for his identification procedures. Chemical kineticists will employ these data in studies of isotope effects.

The NSRDS–NBS publication presents carefully analyzed frequency values for the fundamental modes of vibration of the component molecular segments of 59 molecules. The fundamental frequencies are obtained primarily from infrared and Raman spectra, with microwave spectral information as a secondary source. A second volume, already in the manuscript stage, will provide the same information for 40 additional molecules.

Because these molecules show the effect of successive substitution of deuterium for hydrogen, and because data on structural isomers are emphasized, a wealth of detailed information can be obtained from intercomparison of values from separate tables. Furthermore, the information is transferrable from small molecules to large molecules, and can be applied, for example, to studies of force fields and internal rotation in high polymer molecules.

The molecules covered in the tables are: ammonia, phosphine, arsine, stibine and deuterated equivalents; carbon tetrachloride, chlorinated and deuterated methanes, methanol and deuterated methanols, halogenated ethylenes and ethanes, propane, some butanes, benzene, cyclohexane, and deuterated equivalents, dimethylether, malononitrile, and ethyl cyanide.

The diversity of application of these tables is matched by the wide range of scientific efforts that went into their preparation. The spectral data source material in the first volume came from the world's scientific literature, while much of the fundamental computer-based mathematical analysis was developed at the National Bureau of Standards.

Evaluation of the literature and selection of the values to be included in the tables were done at the University of Tokyo. Professor Takehiko Shimanouchi, the author, is an internationally recognized expert in the field of the tables and has dedicated a substantial portion of his scientific career to this type of work. Advice on presentation of the tables, format, and test material was provided by members of the NBS scientific staff.

Producing Scientific Documents by Computer and Peripheral Devices

The data centers associated with the National Standard Reference Data System require improved techniques for producing scientific text via machine-sensible records. Examples of needs in this area are:

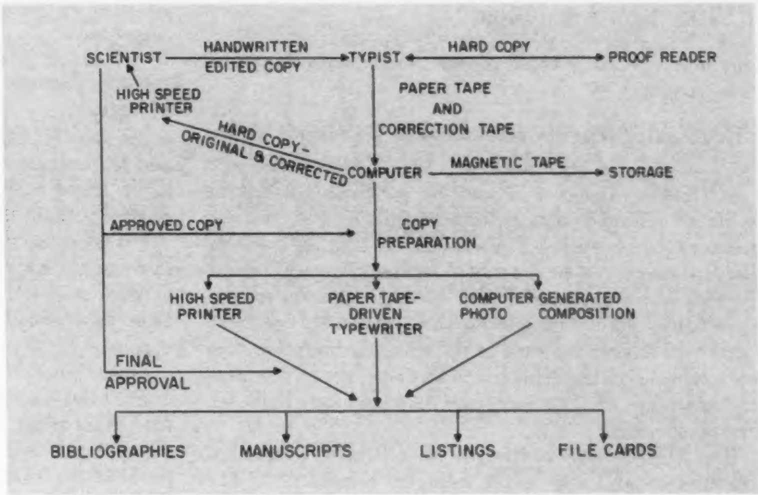
1. The ability to produce updated bibliographies rapidly and at low cost.

2. The ability to manipulate abstracted information by computer to obtain lists and records of selected data.

3. The ability to use original typing effort efficiently in the production of computer-aided photo composition.

The NBS Office of Standard Reference Data is working with the various associated centers to develop systems for meeting these needs.

By-product paper tape can be used in conjunction with a computer to accomplish the desired results (Figure 1). The basic cycle is from scientist to typist to computer and back to the scientist. This cycle is repeated until the corrected copy is approved for production and distribution. The corrected records are maintained on magnetic tape during the cycling and at its conclusion they are

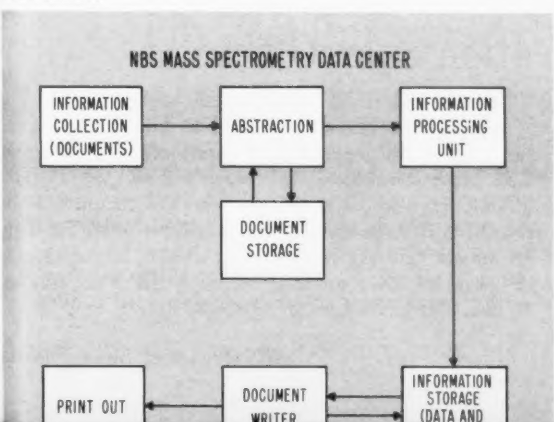


Flow chart showing the process of producing scientific documents with the aid of a computer and special peripheral devices.

stored in a magnetic medium for later updating or other uses.

Key pieces of equipment needed for this process are the paper tape generation device and the high speed printer to provide complete copy for the editing procedures. At the present time, the NBS "Taxywriter" (NSRDS News, July 1966) is considered to be an important addition to the list of existing input devices. In addition to providing upper and lower case codes as do previous machines, it provides the capability to code approximately one hundred additional symbols. The additional symbols, which are simultaneously produced on the paper tape and hard copy, include the Greek alphabet, mathematical graphics, and special characters.

Schematic showing the flow of information from the working data file to the retrieval and printout system used in the NBS Mass Spectrometry Data Center.



An effort is being made to obtain a high speed printer capable of printing all of the symbols generated for input. Meanwhile, an effort is being made to develop the most important element of the total system—the software to make the system workable, flexible, and convenient to use.

NBS Mass Spectrometry Data Center

The NBS Mass Spectrometry Data Center, recently established to provide information on ionic processes for molecules, has now abstracted and made available information contained in about 1000 basic documents published since 1955 on energetics of ionization processes and on ion-molecule reactions. The abstracted data include numerical and bibliographical information on ionization and appearance potentials and on ion-molecule reaction mechanisms and rates. It is available in tabular form on request.

The working data file, retrieval, and printout system are based on a punched-card controlled typewriter. Both the numerical and bibliographic information, when abstracted, are immediately transferred to punched cards and filed. This interrogation and subsequent printout can be performed with a minimum of effort. Also, the file can be readily edited and updated. The information is retrievable by ion, method of obtaining the data (e.g., photoionization, electron impact, theoretical), and year of publication.

Information on ionic processes can be obtained by writing to Dr. H. M. Rosenstock, NBS Mass Spectrometry Data Center, National Bureau of Standards, Washington, D.C. 20234, or calling area code 301–921–2173. A request for specific information can frequently be answered the same

continued

NSRDS NEWS *continued*

day in one or more typed pages. There is no charge for this service.

Economic Benefits of Standard Reference Data

An article in last month's NSRDS News dealt with quantifiable savings that can be achieved by making standard reference data more accessible to the American technical community. The economic benefits of *more reliable* data cannot be computed in the same way as the benefits of *more accessible* data, but these benefits are real nonetheless. They depend on two facts: first, not every numerical answer reported in the scientific literature is as correct as the author claims; and secondly, not all scientists and engineers who use numerical data are aware that such errors do exist.

The NSRDS seeks to improve the reliability of numerical answers available to the technical community. The work is to be done by a large number of scientific specialists, each giving close attention to the area of his own greatest competence. Thus *all* users will have the advantage of compilations prepared by experts. Specific benefits will be obtained from a reduction in the number of mistakes and faulty decisions that are made in situations such as those given below:

(1) Many research and development projects, early in their history, reach a point of critical decision: Can the product be made with existing plant heating or cooling equipment? Can it be made to sell for less than a certain price per pound? Will the new chemical solution be stable when stored in glass bottles? Will the desired chemical reaction supply the new product in high yield? and so on. Answers to questions like these result in decisions to continue or abandon many projects, but the answers themselves may depend on numerical data on heat capacities, thermodynamic activity coefficients, photolysis rate constants, or equilibrium constants. If the numbers used in calculating the answers are incorrect, some invalid negative answers may be obtained, and potentially valuable projects will be abandoned which could have succeeded.

(2) Much more costly (in an immediate sense) are research projects that receive the green light on the basis of faulty data. When a decision point is passed, the project is usually scaled up. More man-hours are scheduled and larger-scale equipment is purchased. If the decision to go ahead was invalid, the cost may run to hundreds of thousands of dollars, especially in the pilot plant stage.

(3) Because so many numerical answers are of uncertain reliability, most industries adopt a procedure of gradual scale-up, going successively from bench-scale to large laboratory-scale to pilot-plant to semi-works development. These successive expansions help to answer many questions and probably could not be eliminated in many cases. But with adequate resources of reliable numerical data, pilot plant and semi-works operations could be designed much more efficiently, and the costs reduced by a factor of 2 or even 10 in many cases. Only the key points of uncertainty would require testing, and the reliability of the pilot plant results themselves could be greatly increased.

(4) A familiar expense in all development and design projects is overdesign. Overdesign has two aspects, one of which appears to be inevitable. Generous allowances for personal safety, expanded use, greater versatility, and so on are evidence of good engineering and foresight. But overdesign and overconstruction required by unreliable input data represent unnecessary and avoidable expense. Any program, such as that being organized by the Office of Standard Reference Data, which provides greater reliability of data on the properties of materials, can bring about substantial economies. Such potential savings are greatest in the areas where weight and size are critical factors (e.g., aircraft and aircraft components; space science and technology; miniature instrumentation; computer technology; biological and medical analysis; diagnosis, and monitoring. This is often the case in this area as the need to overdesign makes the proposed design unacceptable because of fuel demands, size, weight, or flexibility.

NCRP Opens Publication Sales Office

The National Council on Radiation Protection and Measurements (NCRP) has recently decided to publish future NCRP recommendations under its own auspices. The NCRP, formerly the National Committee on Radiation Protection and Measurements, was chartered by Congress in 1964 to collect, analyze, develop, and disseminate scientific information and recommendations about radiation measurement and protection against radiation. In the past most of the major reports of the NCRP were published as NBS Handbooks.

The Council has recently opened an office to handle the sale of all NCRP reports. As a service to the users of NCRP recommendations, this office will sell the 31 NBS Handbooks on radiation protection and measurements. (The NBS Handbooks are also available from the U.S. Government Printing Office.) For a list of NCRP reports and instructions for ordering write: NCRP Publications, P.O. Box 4867, Washington, D.C. 20008.

CLEARINGHOUSE

FOR FEDERAL SCIENTIFIC AND TECHNICAL INFORMATION

Patent Microfilm Service Available

U.S. and foreign industry may purchase 16 mm microfilm copies of all new patents issued by the Patent Office in three categories—General and Mechnical, Electrical, and Chemical—from the Clearinghouse for Federal Scientific and Technical Information. These categories contain the patents announced under the same headings in the Patent Office's Official Gazette.

This step broadens the new microfilm subscription service, announced in January, which covers all patents. The extension of the service is made possible through cooperative arrangements between the Patent Office and the Clearinghouse. The complete program is designed to save industry thousands of dollars previously required to buy, store, and bind complete sets of printed patents.

Patents will be available from the Clearinghouse by category beginning with Patent No. 3,258,799 dated July 5, 1966.

Rates for this service at regular domestic postage are $600 per year for the General and Mechnical category, and $300 per year for both the Electrical and the Chemical categories. Foreign surface mail charges are billed separately. Rates for domestic and foreign air mail will be quoted on request.

The subscription rate for all patents is $830 per year ($20 additional for foreign mailing, $90 additional for foreign air mail). Distribution of the microfilm in individual categories or for all patents will be made within two weeks after the patents are announced in the Official Gazette.

Orders for the service should be sent with payment to the Clearinghouse.*

NBS Corrosion Reference Available

Long out of print, Underground Corrosion, a book that contains basic reference data found nowhere else, has been reproduced in hard copy and is available from the Clearinghouse. The book gives data obtained by the National Bureau of Standards from 1910 to 1955 in its studies of metallic structures buried in soils or in contact with soils.

In these field and laboratory investigations, NBS studied what has long been a serious engineering and economic problem for public utilities, municipalities and, indeed, every nation that moves drinking water and sewage through underground facilities, transports oil and gas through pipelines, and buries its communication, signal, and power cable systems.

Underground Corrision provides a useful reference for the technician, who is interested in the theoretical aspects of underground corrosion, and for the engineer, who may be interested only in the practical aspects of the methods commonly used for the prevention of corrision. It includes many references to industrial studies and field experiences related to the Bureau's underground corrosion investigations.

This book was prepared as NBS Circular 579. It may be purchased for $6.00 as PB–168 350 UNDERGROUND CORROSION from the Clearinghouse.*

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Readers using NBS Miscellaneous Publication 253, General Physical Constants Recommended by NAS–NRC, are reminded that the newest edition is dated Nov. 1965.[1]

The 1965 edition of this wallet-sized card replaces the one dated November 1963. Both cards are white plastic, but the newer has green printing instead of black. Also, the newer one has an important change in the value of the first radiation constant ($2\pi hc^2$), C_1. The figure given in the column headed "value" on the green printed card is 3.7415; on the other card it was erroneously given as 3.7405.

Persons who have the older card may exchange it for the new one free of charge by returning it to the NBS Office of Technical Information and Publications, National Bureau of Standards, Washington, D.C. 20234.

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PUBLICATIONS *of the National Bureau of Standards**

PERIODICALS

Technical News Bulletin, Volume **50**, No. 9, September 1966. 15 cents. Annual subscription: $1.50. 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

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